SECTION 26 4115

LIGHTNING PROTECTION FOR EXPLOSIVE FACILITIES

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LANL MASTER SPECIFICATION

When editing to suit project, author shall add job-specific requirements and delete only those portions that in no way apply to the activity (e.g., a component that does not apply). To seek a variance from applicable requirements, contact the ESM Electrical POC.

When assembling a specification package, include applicable specifications from all Divisions, especially Division 1, General Requirements.

Delete information within “stars” during editing.

Specification developed for ML-3 projects. For ML-1 / ML-2, additional requirements and QA reviews are required.

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PART 1 GENERAL

1.1 SECTION INCLUDES

A. Furnish and install lightning protection system for structures that are used for the storage or handling of explosives including the following:

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Edit the following article to match project requirements. Use mast or catenary systems to protect above ground explosives facilities (MIL-HDBK 1004/6 §4.4.1); integral air terminal systems may be used to protect earth-covered magazines (MIL-HDBK 1004/6 §4.4.2). Use “Faraday-like” shield system to protect the interior and contents of all structures that are used for the storage or handling of explosives. To seek variance from these requirements, contact the ESM Electrical POC or the LANL Lightning Protection SME.

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1. [Mast] [Catenary] [Integral air terminal] primary protection system to protect the above-ground structure.

2. Integral air terminal secondary protection system to protect earth-covered magazines.

3. Faraday-like shield system to protect the interior and contents of the structure from high electric fields.

4. Interconnecting lightning protection conductors.

5. Grounding and bonding for lightning protection.

6. Lightning protection grounding electrode system.

7. Surge suppressors on all conductors entering the structure.

1.2 LANL PERFORMED WORK

A. LANL will inspect the lightning protection system for acceptance.

1.3 PERFORMANCE REQUIREMENTS

A. Provide lightning protection system that conforms to the requirements of:

1. DOE M 440.1-1, Explosives Safety Manual.

2. NFPA 780, Standard for the Installation of Lightning Protection Systems, including Appendix K “Protection of Structures Housing Explosive Materials”.

3. MIL-HDBK 1004/6, Lightning Protection.

B. Protect the entire building including roof projections, chimneys, roof mounted equipment, associated exposed structures, electrical services, antennas, alarm services, and telecommunications services.

C. Design primary protection system based on a 100 foot lightning striking distance as defined in NFPA 780.

D. Design grounding system to achieve a ground resistance of not over 10.0 ohms.

1.4 SUBMITTALS

A. Submit the following in accordance with Section 01 3300, Submittal Procedures.

1. Catalog data for each component of the lightning protection system, including data substantiating that material complies with specified requirements. Include data for roof adhesive when used.

2. Certifications demonstrating that firms meet qualifications specified in “Quality Assurance” article to demonstrate capabilities and experience. Include list of completed projects with project names, addresses, names of Architects and Owners, and other information specified.

3. Materials list of lightning protection system components showing quantity and manufacturer's catalog number.

4. Shop drawings, not smaller than 1/8” = 1'-0” scale, showing the type, size, and locations of counterpoise, ground rods, down conductors, through roof/through wall assemblies, roof conductors, air terminals, and bonding connections, lightning masts, aerial cables, and support poles as applicable.

5. Project record documents that accurately record actual locations of counterpoise, ground rods, down conductors, through roof/through wall

assemblies, roof conductors, air terminals, and bonding connections, lightning masts, aerial cables, and support poles as applicable.

6. Test reports for all inspection and testing required by this Section.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: Engage a qualified installer to design and install the lightning protection system. Installer shall have either a current LPI Master Installer certification or current UL listing (Category OWAY) for Lightning Protection Installation. The installer shall have successfully completed not less than 5 lightning protection installations of similar scope to this project.

B. Inspection: LANL will inspect the lightning protection system for acceptance in accordance with NFPA 780, MIL-HDBK 1004/6, and DOE M 440.1-1.

C. Listing and Labeling: Provide products that are NRTL listed for lightning protection use.

1.6 SEQUENCING AND SCHEDULING

A. Coordinate installation of lightning protection system with the installation of other building systems and components, including electrical wiring, supporting structures and building materials, metal bodies requiring bonding to lightning protection systems, and building finishes.

B. Coordinate inspections so lightning protection conductors and bonding connections will be inspected and photographically documented before being covered with concrete or other building materials.

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Edit the following article to match project requirements.
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1.7 RECEIVING, STORING, AND PROTECTING

A. RECEIVE, STORE, AND PROTECT, AND HANDLE PRODUCTS ACCORDING TO NECA 1—Standard Practices for Good Workmanship in Electrical Construction.

B. Store poles on decay-resistant treated skids at least 1 foot above grade and vegetation. Support poles to prevent distortion and arrange to provide free air circulation.

C. Wood Poles: Do not drag wood poles along the ground. Do not handle with tongs, hooks or other pointed tools. Do not apply tools to ground line section of poles.

D. Keep factory applied wrappings on metal poles until immediately before pole installation. Handle poles with web fabric straps.

E. Handle conductors to prevent nicking, kinking, gouging, flattening, or otherwise deforming or weakening conductor or impairing its conductivity.

PART 2 PRODUCTS

2.1 PRODUCT OPTIONS AND SUBSTITUTIONS

A. Refer to Section 01 2500, Substitution Procedures.

2.2 LIGHTNING PROTECTION MATERIAL - GENERAL

A. PROVIDE LIGHTNING PROTECTION MATERIALS AND COMPONENTS THAT CONFORM TO UL 96 - Lightning Protection Components.

B. Use copper conductors and bronze fittings. Use aluminum only where in contact with aluminum structure, roofing, or mechanical equipment.

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Edit the following article to match project requirements. This paragraph is typically used for modifications to existing systems.
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C. Existing lightning protection material and components that meet the requirements of this Section and are in good condition may be re-conditioned and re-used. Re-conditioning includes removal of adhesive, removal of corrosion, and wire brushing contact areas.

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Delete the following article when a “catenary cable system” is not contemplated.
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2.3 CATENARY CABLE SYSTEM MATERIALS

A. Catenary Cable:

1. PROVIDE NON-CORROSIVE, COPPER-COATED, HIGH-STRENGTH STEEL CABLE, CONFORMING TO ASTM B228, Standard Specification for Concentric-Lay-Stranded Copper-Clad Steel Conductors.

2. Minimum cable size: 3/8 inch diameter with seven 8 AWG strands. Provide larger cables as indicated on the Drawings.

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The following article specifies wood poles. Other pole materials, such as concrete or metal may be more appropriate for a particular project. The designer/specification writer should coordinate such issues with the LANL lightning protection SME.
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B. Wood Poles:

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Edit the following article to meet project requirements.
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1. Provide wood poles conforming to ANSI 05.1; treated [Douglas fir] [Southern pine] poles of [minimum length and class indicated]. [[ ] feet length minimum, Class [ ] minimum.]

2. Select poles for straightness. Provide poles that do not have sweeps or short crooks exceeding 50 percent of the maximum sweeps or short crooks permitted in ANSI Standards 05.1 and present a neat appearance after installation.

3. Provide poles that comply with ANSI Standard 05.1, and are machine-trimmed by turning; pressure treated in accordance with AWPA Standard C1 and C4; and are treated with oil-borne preservatives and petroleum conforming to AWPA Standards P9, Type B or D only.

4. Mark each pole in accordance with the requirements of ANSI Standard 05.1. Locate markings on the face of the pole approximately 10 feet from the butt of the pole. Where specifically approved, the marking on the face of the pole may be at other locations standard with pole manufacturer.

5. The quality of each pole shall be ensured with “WQC” (wood quality control) brand on each piece, or by an approved inspection agency report.

6. Provide poles with a 30-degree, one-way roof.

C. Pole Hardware

1. Provide pole hardware required for a complete installation.

2. Finish: Hot-dipped galvanized after fabrication.

3. Eye Bolts and Nuts: ANSI C135.4.

4. Anchor Rods and Nuts: ANSI C135.2.

5. Bolts and Nuts: ANSI C135.1.

6. Eyenuts and Eyelets: ANSI C135.5.

7. Guy Strand: High strength 7-strand steel cable galvanized to ASTM A467, Class A or B. Catenary cable may be used if of suitable strength.

8. Cable Terminations: Three-bolt clamp type.

9. Guy Guards: 8 foot long Plastic, colored yellow.

D. Anchors and Anchor Rods

1. Earth anchors shall be of the [8-inch] [-inch] [8-way expanding] [ ] type, designed for use with [3/4-inch] [1-inch] [-inch] anchor rods. Rated holding power for the anchors shall be:

   a. Sand: 10,000 lb

   b. Clay: 18,500 lb

   c. Hardpan: 26,500 lb

2. Anchor rods shall be [3/4-inch] [1 inch] diameter, [8] [10] [ ] feet long, twin-thimble-eye threaded, hot-dip galvanized steel. The ultimate strength of the rods shall be at least [23,000 lb] [lb]. The threaded end section of the rod shall be at least [3-1/2] [ ] inches long.

3. Rock anchors shall be [2-1/4] [ ] inches in diameter with [1" x 53"] [ ] anchor rods attached. The anchors shall be designed for installation in a rock hole drilled with a [2-3/8-inch] [-inch] rock drill. The anchor shall be so designed that, after installation, the anchor will wedge against the rock as tension is applied by the guy.

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Delete the following article when a "lightning mast system" is not contemplated. This article specifies metal poles. Other pole materials, such as concrete or wood may be more appropriate for a particular project. The designer/specification writer should coordinate such issues with the LANL lightning protection SME.

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LIGHTNING MAST SYSTEM MATERIALS

E. Furnish metal lightning masts and accessories that comply with requirements indicated on the Drawings and as specified below.

F. Provide masts that conform to AASHTO LTS-1 - Standard Specifications for Structural Supports for Highway Signs, Luminaires and Traffic Signals.

G. Provide tapered round steel masts that are fabricated from tubing conforming to ASTM A 500, Grade B, carbon steel with a minimum yield of 46,000 psi. Poles shall be one-piece construction up to 40 feet in length. Poles over 40 feet in length may be in two sections with an overlapping joint. Provide poles with hot dipped galvanized finish.

H. Provide mast, reinforced concrete base, and anchorage rated for the indicated height with an 80 mph wind and a 1.3 gust factor.

I. Provide two sets of welded 1/2 inch NEMA two-hole lug pattern grounding lugs on opposite sides of each mast, 12 inches above the base plate.

J. Provide masts with anchor type bases and galvanized steel anchor bolts, leveling nuts and bolt covers.

K. Provide fasteners and other appurtenances fabricated from corrosion resistant materials that are compatible with masts and will not cause galvanic action at contact points.

L. For each mast provide a mast-top tenon that is fabricated to support a lightning protection air terminal and is securely fastened to the pole top.

****
Delete the following article when an “integral system” is not contemplated. Integral systems may only be used for underground magazines.
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2.4 INTEGRAL AIR TERMINAL SYSTEM MATERIALS

A. Air terminals:

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Edit the following article for copper or aluminum material.
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1. Provide 1/2 inch diameter, rounded tip, solid copper air terminals. Use 5/8 inch diameter, rounded tip, solid aluminum air terminals where in contact with aluminum structure, roofing, or mechanical equipment. Air terminal tips shall have a tip radius of curvature of 3/16 inch minimum to 1/2 inch maximum.

2. Provide a base for each air terminal that has a bolted pressure type cable connector, will support the terminal in a vertical position, and is suitable for the surface to which it will be attached.

B. Conductors

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Edit the following article to match project requirements. If structure is more than 75 feet in height, change conductor to Class II material as described in NFPA 780.
****

1. Main Conductor: Provide copper cable with minimum 17 AWG strand size and a minimum cross sectional area of 57,400 circular mils. Use aluminum cable with minimum 14 AWG strand size and a minimum cross sectional area of 98,600 circular mils where in contact with aluminum structure, roofing, or mechanical equipment.

2. Bonding Conductor: Provide copper cable with minimum 17 AWG strand size and a minimum cross sectional area of 26,240 circular mils. Use aluminum cable with minimum 14 AWG strand size and a minimum cross sectional area

of 41,100 circular mils where in contact with aluminum structure, roofing, or mechanical equipment.

C. Provide bolted pressure type connectors; finger, crimp, or pressure saddle style cable connectors are not acceptable.

D. Provide adhesive for cable fasteners and air terminal bases that is compatible with surface or roofing material to which bases or fasteners are to be attached.

2.5 GROUNDING SYSTEM MATERIAL

A. Ground Rods

1. Provide NRTL listed ground rods as shown on the Drawings.

2. Furnish ground rods that comply with ANSI C135.30 with high-strength steel core and electrolytic-grade copper outer sheath, molten welded to core, approximately 10 feet long, 3/4 inches in diameter.

3. Manufacturers: Blackburn, Thomas & Betts, Harger.

B. Ground Cable

1. PROVIDE BARE STRANDED, SOFT TEMPER COPPER CABLE THAT CONFORMS TO ASTM B8, Standard Specification for Concentric-Lay Stranded Copper Conductors.

2. Provide cable size as indicated on the Drawings or specified in this Section.

C. Ground Electrode Backfill Material

1. Provide a Bentonite clay or equivalent commercial ground enhancement backfill material for ground rods and cable type electrodes.

2. Backfill material, when at 300% moisture content (weight of water/weight of material)x (100), shall have a resistivity of approximately 250 ohm-cm and a pH of 8 to 10.

3. Manufacturers: WYO-BEN Inc, ERICO

2.6 CONNECTORS

A. Bolted Ground Connectors

1. Provide NRTL listed copper alloy bolted connectors with silicon bronze hardware for making cable connections to pipes, ground rods, exposed structural steel, roof deck, and wall panels.

2. Manufacturers: Blackburn, Burndy, O.Z.

B. Exothermic Weld Connections

1. Provide molds and welding material in kit form for making exothermic weld connections.

2. Match mold and weld material to material types, shapes and sizes to be joined.

3. Manufacturer: ERICO Cadweld

C. Compression Grounding Connectors

1. Provide NRTL listed wrought copper connectors, terminals and splices for making compression grounding connections on concentric lay ground electrode cable and bonding connections to reinforcing steel.

2. Furnish connectors that have been tested successfully according to the requirements of IEEE Std. 837 - IEEE Standard for Qualifying Permanent Connections Used in Substation Grounding.

3. Provide hydraulic compression tools and dies that match the connectors.

4. Match connector and die size to material shapes and sizes to be joined.

5. Manufacturer: Blackburn, Burndy

2.7 SURGE SUPPRESSORS

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Edit the following article to match project requirements. Coordinate with specifications for electrical service equipment.
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A. Line Voltage Circuits:

1. FOR EACH LINE VOLTAGE POWER AND CONTROL CIRCUIT ENTERING THE STRUCTURE PROVIDE UL 1449 LISTED SECONDARY SURGE ARRESTERS THAT COMPLY WITH IEEE C62.11, IEEE Standard for Metal-Oxide Surge Arresters for AC Power Circuits AND ARE RATED FOR “LOCATION CATEGORY C3” AS DEFINED IN IEEE C62.41, IEEE Guide for Surge Voltages in Low-Voltage AC Power Circuits.

2. Manufacturer: Square D “SDSA3650” for three-phase 480Y/277V and 208Y/120V systems; Square D “SDSA1175” for single-phase 120V and 120/240V systems.

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Edit the following article to match project requirements; more than one type of antenna arrester may be required. Coordinate requirements with User or Facility Manager to determine proper arrestor specification.
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B. Antenna Leads:

1. For each antenna cable entering the structure provide broadband HF/VHF/UHF coaxial surge protectors suitable for the frequency and power level.

2. Manufacturer: Polyphaser

C. TELECOMMUNICATIONS CIRCUITS: FOR EACH TELECOMMUNICATIONS CIRCUIT ENTERING THE STRUCTURE, PROVIDE SURGE PROTECTORS THAT COMPLY WITH UL 497, Standard for Protectors for Paired-Conductor Communications Circuits. COORDINATE WITH SPECIFICATION SECTION 27 1000, Structured Cabling.

D. Fire Alarm Circuits: For each fire alarm circuit entering the structure provide surge protectors that comply with UL 497B, Standard for Protectors for Data Communications and Fire Alarm Circuits. Coordinate with specification Section 28 3100, Fire Detection and Alarm.

E. Low-voltage Control Circuits: For each low-voltage (i.e. 5 V or 24 V) control circuit entering the structure provide surge protectors that comply with UL 497B, Standard for Protectors for Data Communications and Fire Alarm Circuits.

PART 3 EXECUTION

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Delete the following article when existing construction is not affected.
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3.1 EXISTING WORK

A. Disconnect and remove abandoned lightning protection system components.

B. Clean and repair existing lightning protection components that are to remain or be reinstalled.

C. Inspect, test, and repair the parts of the existing lightning protection system on the structure that are to remain in service. Use test instruments that are capable of measuring within plus or minus 10 percent of the required reading and have current calibration. Provide certified test results and instrument calibration information to the LANL Construction Inspector.

1. Make continuity tests of concealed parts of existing systems that may be re-used and are not available for visual inspection.

2. Perform resistance measurements of all bonding connections to verify that the resistance of any object bonded to the existing lightning protection system does not exceed 1 ohm.

3. Perform continuity tests to verify that electric service(s), telecommunications service(s), antenna system grounds, and underground metallic piping systems are bonded to the existing lightning protection system.

4. Perform ground-impedance measurements of existing lightning protection grounds to verify that ground resistance is less than 10 ohms.

   a. Perform ground resistance measurements with the lightning protection ground system temporarily disconnected from all other grounding and piping systems.

   b. Use the “fall-of-potential” method in accordance with IEEE 81, Guide for Measuring Earth Resistivity, Ground Impedance and Earth Surface Potentials of a Grounding System. Use instrumentation specifically designed for ground impedance testing as defined in Section 12 of the above guide. Provide sufficient spacing of test electrodes so that the plotted curves flatten in the 62% area of the distance between the item under test and the current electrode. When sufficient spacing of electrodes is impractical for the “fall-of-potential” method, perform ground-impedance measurements using either the “intersecting curves method” or the “slope method”, references 40 and 41 in IEEE Std. 81.

   c. If the lightning protection ground system resistance exceeds 10 ohms, add ground rods, plates, or other approved electrodes to obtain 10 ohms or less.

D. Visually inspect existing surge suppression devices on electrical services, electrical circuits, and communications, alarm, control, and antenna systems for indication of damage. Replace missing or damaged surge suppression devices.

3.2 EXAMINATION

A. Examine surfaces and conditions, with Installer present, for compliance with installation tolerances and other conditions affecting performance of the lightning protection system. Do not proceed with installation until unsatisfactory conditions have been corrected.

B. Verify that power, control, communications, and alarm services and circuits entering the structure are installed underground for not less than 50 ft from the point they are exposed to lightning.

3.3 INSTALLATION - GENERAL

A. Install lightning protection system according to NFPA 780, MIL-HDBK 1004/6, DOE M 440.1-1, as specified in this Section and as shown on the Drawings.

B. Install lightning protection components according to the manufacturer's written instructions.

C. Install conductors with direct paths from air terminals to ground connections. Avoid sharp bends and narrow loops.

D. Install a down conductor disconnect in each down conductor except the one nearest the building electrical service entrance. Locate disconnect between 8 ft and 10 ft above grade.

E. Cover lightning protection down conductors that are subject to physical damage or casual contact by personnel with Schedule 80 PVC conduit. Cover down conductors from grade level up to 8 ft above grade. Support conduit with conduit clamps spaced not more than 36 inches apart.

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Edit the following article to match project requirements.
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3.4 LIGHTNING PROTECTION GROUNDING ELECTRODE SYSTEM

A. Install a counterpoise ring around the structure and any masts or catenary support guy anchors.

B. Use minimum 1/0 AWG ground cable

C. Install counterpoise cable not less than 5 ft outside the building perimeter and at least 6 ft from any electrical system or communications system grounding. Install the counterpoise at least 3 ft below grade. Anchor conductor using driven ground rods.

D. Encase the counterpoise in a 2 inch envelope of ground electrode backfill material slurry.

E. Connect the counterpoise to the main grounding electrode ground bar located near the building electrical service entrance.

3.5 LIGHTNING PROTECTION CONNECTIONS

A. Clean contact surfaces to which lightning protection connections are to be made. Remove non-conductive coatings such as paint, enamel, and oil film.

B. Use the following connection methods unless otherwise specified or indicated on the Drawings:

1. Use bolted connectors for connecting to ground rods.

2. Use exothermic weld connections for underground or concealed connections of dissimilar materials.

3. Use exothermic weld or compression grounding connections for underground or concealed connections of like materials. Do not use compression grounding connectors for rope lay lightning conductor connections or for lightning protection ground rod connections.

4. Use exothermic weld or bolted connections for accessible connections.

5. Use high strength silicon bronze bolts, nuts, flat washers and toothed lockwashers for making bolted connections.

C. Tighten lightning protection connectors, screws and bolts in accordance with manufacturer's published torque tightening values for connectors and bolts. Where manufacturer's torquing requirements are not indicated, tighten connections to comply with torque tightening values specified in UL 486A and UL 486B. Use a calibrated torque wrench.

D. Use hydraulic compression tools to provide the correct circumferential pressure for compression connectors. Use tools and dies recommended by the manufacturer of the connectors. Provide embossing die code or other standard method to make a visible indication that a connector has been adequately compressed.

E. Install exothermic welds in accordance with manufacturer's instructions and recommendations. Welds that are puffed up or that show convex surfaces indicating improper cleaning are not acceptable.

F. Make connections in such a manner as to minimize possibility of galvanic action or electrolysis. Select connectors, connection hardware, conductors, and connection methods so metals in direct contact will be galvanically compatible.

1. Use electroplated or hot-tin-coated materials to assure high conductivity and make contact points closer in order of galvanic series.

2. Make connections with clean bare metal at points of contact.

3. Make aluminum to steel connections with stainless steel separators and mechanical clamps.

4. Make aluminum to galvanized steel connections with tin-plated copper jumpers and mechanical clamps.

5. Coat and seal connections involving dissimilar metals with inert material such as red lead paint to prevent future penetration of moisture to contact surfaces.

G. Protect lightning protection connections to prevent them from being painted or covered with material such as fire proofing or roofing adhesive.

3.6 SURGE SUPPRESSOR INSTALLATION

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Edit the following article to match project requirements. Coordinate with specifications for electrical service equipment.
****

A. Install surge suppressors on electrical services. Install surge arresters on electrical circuits where they enter the structure from roof-mounted equipment or from locations exposed to lightning.

1. Perform suppressor installation only on de-energized equipment.

2. Schedule service de-energizing with Facility Manager.

3. Install surge suppressors in accordance with manufacturer's instructions.

4. Install surge suppressors in service equipment to minimize length of leads. Connect surge arresters to the line side of the service disconnecting means.

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Edit the following article to match project requirements.
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B. Install surge suppressors on antenna lead-in cables where they enter the structure.

1. Perform suppressor installation only on de-energized equipment.

2. Schedule antenna service de-energizing with Facility Manager.

3. Install surge suppressors in accordance with manufacturer's instructions.

****
Edit the following article to match project requirements.
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C. Install surge suppressors on fire alarm and control circuits where they enter the structure.

1. Perform suppressor installation only on de-energized equipment.

2. Schedule fire alarm or control system de-energizing with Facility Manager.

3. Install surge suppressors in accordance with manufacturer's instructions.

****
Edit the following article to match project requirements.
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D. Arrange for the installation of new surge suppressors on telecommunications circuits where suitable suppressors are missing or damaged.

1. Coordinate installation with the LANL Telecommunications Group.

2. Provide suitable ground connection for the telecommunications circuit surge suppressors.

3.7 FARADAY SHIELD INSTALLATION

A. Bond reinforcing steel in floor slab to reinforcing steel in foundation. Bond reinforcing steel in floor slab to reinforcing steel in exterior walls or to metal wall panels. Bond reinforcing steel in exterior walls or metal wall panels to reinforcing steel in roof or to metal roof deck. Distance between bonds must not exceed 36 inches. Use not smaller than 6 AWG bonding conductor and NRTL listed bonding fittings. Reinforcing bar splices that are overlapped at least 20 bar diameters and wire tied are acceptable bonds.

B. Bond metallic pipe, conduit, duct, and similar entries to the reinforcing steel at the perimeter of the Faraday cage. Distance between bonds must not exceed 36 inches. Use not smaller than 6 AWG bonding conductor and NRTL listed bonding fittings.

C. Bond door frames to wall and floor reinforcing bars. Bond interval must be 36 inches or less. Use not smaller than 6 AWG bonding conductor and NRTL listed bonding fittings.

D. Bond doors to door frames. Bond interval must be 18 inches or less along the hinge side. Use tinned copper braid not smaller than 1 inch wide, 1/8 inch thick. Fasten braid using hex head stainless steel screws threaded into in tapped holes in the doors and door frames.

****
Delete the following article when a catenary system is not contemplated.
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3.8 CATENARY SYSTEM INSTALLATION

A. Install support poles at locations indicated on the Drawings.

1. Plug unused holes in poles using treated wood dowel pins. Treat field-cut gains and field-bored holes with preservative.

2. Shorten poles when required by cutting from top end. Apply hot preservative to shortened end of pole.

3. Dig setting holes large enough to permit use of tampers to full depth. Place earth in maximum 6-inch layers and pack to 95 percent density.

4. Embed poles at depths indicted in Table 1 below.

5. Rake poles located at corners, angles, and dead ends so that poles are vertical after line installation.

6. Do not install poles along the edge of cuts and embankments or where soil may be washed out.

Table 1 - Pole Embedment Depth Requirements

Pole Length (ft)	Embedment Depth in Soil (ft)	Pole Top Height in Soil (ft)	Embedment Depth in Solid Rock (ft)	Pole Top Height in Solid Rock (ft)
30	5.5	24.5	3.5	26.5
35	6.0	29.0	4.0	31.0
40	6.0	34.0	4.0	36.0
45	6.5	38.5	4.5	40.5
50	7.0	43.0	4.5	45.5
55	7.5	47.5	5.0	50.0
60	8.0	52.0	5.0	55.0

Notes:
1. "Embedment depth in soil" depths must apply:
   a. Where the poles are to be set in soil.
   b. Where there is a layer of soil more than 2 feet deep over solid rock.
   c. Where the hole in solid rock is not substantially vertical or the diameter of the hole at the surface of the rock exceeds approximately twice the diameter of the pole at the same level.
2. "Embedment depth in solid rock" depths may apply:
   a. Where the poles are to be set in solid rock and where the hole is substantially vertical, approximately uniform in diameter and large enough to permit the use of tamping bars the full depth of the hole. When there is a layer of soil 2 feet or less dept over solid rock, the depth of the hole must be the depth of the soil in addition to the "Embedment Depth in Solid Rock" value.
3. On sloping ground, the depth of the hole must be measured from the low side of the hole.

B. Install and sag conductors according to MIL-HDBK 1004/6.

C. Anchors and Guys

1. Place anchors in line with strain. The length of the guy lead (distance from base of pole to the top of the anchor rod) shall be as indicated.

2. Set anchors in place with anchor rod aligned with, and pointing directly at, guy attachment on the pole with the anchor rod projecting 6 to 9 inches out of ground to prevent burial of rod eye.

3. Complete anchor and buy installation, dead end to dead end, and tighten guy before wire stringing and sagging is begun on that line section.

4. Provide hardware with washer against wood and with nuts and lock nuts applied wrench tight. Provide locknuts on threaded hardware connections. Locknuts shall be M-F style and not palnut style.

5. Install a full round bright yellow polyethylene guy guard at least 8 feet long on each guy wire.

D. Connect each guy wire to the grounding electrode counterpoise.

****
Delete the following article when a lightning mast system is not contemplated.
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3.9 LIGHTNING PROTECTION MAST INSTALLATION

A. Install lightning protection masts at locations indicated on the Drawings.

B. Construct concrete foundations with 4000 psi, 28 day concrete and reinforcing conforming to Division 3 Section “Cast-In-Place Concrete”. Comply with details on the Drawings and pole manufacturer's recommendations for foundation dimensions, reinforcing, anchor bolts, nuts and washers.

C. Cure concrete foundations for 7 full curing days before erecting poles.

D. Use fabric web slings to raise and set poles.

E. Torque anchor bolt nuts and other pole hardware as recommended by manufacturer.

F. After pole is leveled, pack non-shrink grout between anchor base and concrete foundation to provide a full bearing surface.

G. Install two ground conductors from each mast to the grounding electrode counterpoise.

****
Use integral systems only for explosives facilities consisting of earth-covered magazines. Delete the following article when an “integral system” is not contemplated.
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3.10 INTEGRAL SYSTEM INSTALLATION ON EARTH-COVERED MAGAZINE

A. Where one or more metal ventilator provides a salient point above the structure, install and air terminal on each ventilator. Connect air terminals to the counterpoise with at least two horizontal or downward leading main conductors.

B. On the portal wall install an air terminal within 2 feet of each end. Install additional air terminals do the spacing between air terminals will not exceed 20 feet. Connect air terminals to the counterpoise with at least two horizontal or downward leading main conductors.

3.11 FIELD QUALITY CONTROL

A. Use test instruments that are capable of measuring within plus or minus 10 percent of the required reading and have current calibration.

B. Test the lightning protection grounding electrode system using the “fall of potential” method. Make test at least 30 days after installation of the electrode and before any connections are made to the electrode. Verify that resistance to earth reading is 10 ohms or less. Supplement grounding electrode if resistance exceeds 10 ohms. Use test instruments that are designed specifically for earth resistance testing. Provide certified test results and instrument calibration information to the LANL Construction Inspector.

C. Inspect and test the primary protection system to determine:

1. That the system complies with the current requirements of NFPA 780 Chapter 3, Chapter 6, Appendix B, and Appendix K.

2. That all required bonds are in place and are secure.

3. That all AC power lines, communications, and data lines that enter the facility have surge suppression devices that are properly installed and functional.

4. That the resistance of each bond is 1 ohm or less.

5. Take corrective action to correct deficiencies. Provide certified inspection and test results and instrument specifications and calibration information to the LANL Construction Inspector.

D. Inspect and document the construction of the Faraday-like shield system(s) as follows:

1. Make digital construction photographs showing electrical continuity of walls, floor and ceiling before work is covered with concrete or other building materials.

2. Request LANL inspection of electrical continuity of walls, floor and ceiling before work is covered with concrete or other building materials.

3. Make digital construction photographs showing bonding of all metallic penetrations of walls, floor and ceiling before work is covered with concrete or other building materials.

4. Request LANL inspection of bonding of all metallic penetrations of walls, floor and ceiling before work is covered with concrete or other building materials.

5. Take corrective action to correct deficiencies. Provide certified inspection results and construction photographs to the LANL Construction Inspector.

E. Inspect and test the Faraday-like shield system(s) to determine:

1. That there is proper bonding or electrical continuity of the walls, ceiling, and floor by measuring the transfer impedance versus frequency using and appropriate test instrument and procedure.

2. That there is proper bonding of all conductive penetrations of the Faraday-like shield by inspection of building documentation, inspection of the facility, inspection of construction photographs, and by resistance readings.

3. That all AC power lines, communications, and data lines that penetrate the Faraday-like shield have surge suppression devices that are properly installed and functional.

4. Take corrective action to correct deficiencies. Provide certified inspection and test results and instrument specifications and calibration information to the LANL Construction Inspector.

F. An inspection of the lightning protection system will be conducted by the LANL Construction Inspector prior to system acceptance.

1. Primary protection system

2. Secondary protection system

3. Down conductors

4. Grounding system ground resistance.

5. Bonding resistances.

G. Notify the LANL Construction Inspector 10 working days in advance of the expected completion of the lightning protection system installation. Inspection can be scheduled in parts or by area depending on the system and construction schedule.

H. Promptly correct all deficiencies as required by the Contract Administrator.

END OF SECTION

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Bases**:** Section 2.3, Catenary Cable System Materials: Requirements are from LANL Specification Sections 16301 and 16370.

Section 2.4, Lightning Mast System Materials: Requirements are from MIL-HDBK 1004/6, Section 3.

Section 3.5.B.1: Requirement in MIL-HDBK 1004/6.

Section 3.7, Faraday Shield Installation: Requirements are from DOE M 440.1-1.

Section 3.11.B: Requirement is from MIL-HDBK 1004/6 §4.2.1.

Section 3.11.C: Inspection and test requirements for primary system from DOE M 440.1, Chapter X, §3.0-a.1.

Section 3.11.E: Inspection and test requirements for Faraday-like shield system from DOE M 440.1, Chapter X, §3.0-a.2.

Do not delete the following reference information:

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FOR LANL USE ONLY

This project specification is based on LANL Master Specification 26 4115 Rev. 0, January 6, 2006.